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W. T. Blanford

THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE V. VOL. II.

No. I.—JANUARY, 1905.

ORIGINAL ARTICLES.

I.—Eminent Living Geologists:

William Thomas Blanford, C.I.E., LL.D., F.R.S., V.P. Zool. Soc., Treas. Geol. Soc.

(WITH A PORTRAIT, PLATE I.)

WHAT India has been in the past 300 years to our Army as a nursery in which our soldiers have obtained experience in their profession and earned their promotion, often to the highest rank, such in a lesser degree has it been to many of our geologists, who have, in the past much shorter period of 50 or 60 years, entered the service in this vast field of scientific enterprise, and, aided by a very few amateur geologists in the Army and of civilians attached to other branches of Government employ, have covered many thousand square miles of our Indian Empire with records of their untiring energy in the geological field.

Among the amateurs may be recorded the names of Generals Sir Richard Strachey and Sir Proby T. Cautley, Dr. Hugh Falconer, Lieut-Gen. C. A. McMahon; and as professional geologists, Dr. T. Oldham, H. B. Medlicott, J. G. Medlicott, Dr. Wm. King, Dr. Valentine Ball, the two Blanfords, W. Theobald, R. Bruce Foote, A. B. Wynne, C. L. Griesbach, R. D. Oldham, F. R. Mallet, C. S. Middlemiss, T. D. La Touche, Dr. F. Stoliczka, Professor W. Waagen, the present Director (T. H. Holland), and many others.

Prominent among the earlier geological workers stand out the names of the brothers W. T. and H. F. Blanford, who joined the Indian Survey together in 1855. Having served on the staff for seven years, the younger left in 1862, being appointed to the Educational service, and subsequently as head of the newly constituted Meteorological Department for India, a post which he held until 1888, when he retired, and died in 1893 (see notice of his life and work, Geol. Mag., 1893, pp. 191–2).

William T. Blanford, the surviving brother, and the subject of the present memoir, was born on 7th October, 1832, at 27, Bouverie Street, Whitefriars, in the City of London. The house and manufactory adjoining it belonged to his father, William Blanford, the

whole having been built and established by him. This house, with some others adjoining it, and also the manufactory, now form the printing and publishing offices of the *Daily News*.

W. T. Blanford received his early education in private schools at Brighton, and afterwards in Paris. He was sent to Paris at the age of 14, and remained there till March, 1848, just after the Revolution. He happened to be laid up during that critical time in January with a severe bronchial attack, doubtless diphtheria, and was in bed during the eventful change of government from the rule of Louis Philippe to the temporary government by the National Assembly. He suffered for a considerable time from results of this illness, and passed two years with a mercantile house at Civita Vecchia, in the Roman States (then occupied by the French), the head of the firm being an old friend of his father's.

Returning to England in 1851, he joined his father's business, but his younger brother, Henry, having meantime matriculated at the Royal School of Mines, which had opened in that year, the temptation to abandon business and take up a scientific career was too strong, and he followed his brother and entered the Laboratory under Lyon Playfair in 1852 and matriculated in October of that year. The course was only for two years, and both brothers passed out at the head of the list, each having carried off the Duke of Cornwall's and the Council Scholarships. The vacations were spent by the brothers in studying field-geology with Professor (afterwards Sir A. C.) Ramsay, and mining in Cornwall with Professor (afterwards Sir W.) Warington Smyth; one Autumn being passed in travelling in Norway.

Besides Lyon Playfair (afterwards Lord Playfair), Ramsay, and Warington Smyth, Edward Forbes lectured on Natural History, and Percy was Professor of Metallurgy; these were the principal teachers in the School of Mines in 1852–4, of which Sir Henry T. De la Beche was the Director. Huxley joined the staff towards the end of the time, and W. T. Blanford had the advantage of hearing one or two of his earlier lectures.

After leaving the School of Mines in 1854, a year was passed at Freiberg in Saxony in the study of chemistry, mineralogy, mining, and metallurgy. Before this year came to an end, the brothers were offered and accepted posts on the Geological Survey of India, under Dr. Thomas Oldham, F.R.S., the then Superintendent. They sailed for India in the late Summer, and arrived in Calcutta at the end of September, to find that Dr. Oldham was away with Colonel Phayre's mission to the Court of Ava, and no information of their appointment had been received by any Government official. There was no Survey office at that time, and it was only by chance the brothers met Mr. W. Theobald, a member of the Survey staff. There were no telegraphs in those days, and posts were slow, so that nearly two months elapsed before hearing from Dr. Oldham. Part of the time was spent in a visit to the Raniganj Coalfield, and in the study of Hindustani. On Dr. Oldham's return to Calcutta in December everything was arranged, and in January, 1856, a party

consisting of W. T. and H. F. Blanford, with Mr. Theobald, was despatched to examine and report on a coalfield near Talchir, about 60 miles north-west of Cuttack in Orissa.

This survey had some important geological results. The coal was found to be abundant, though of very inferior quality, but the first steps in the classification of the Indian coal-bearing rocks were taken in the separation of a lower division called Talchir, and of a higher group, provisionally classed as Mahadeva, from the coal-bearing beds themselves, to which the name Damuda series was given by Dr. Oldham. This subdivision proved the key to the classification of the great series of formations subsequently named the Gondwána system. Another and even more interesting discovery was the occurrence of large boulders in fine silt in the Talchir strata, and it was suggested that the boulders had reached their present position by the agency of ice, a view which, although long regarded as doubtful, has in the course of the last thirty years been abundantly confirmed by discoveries of a similar formation of like geological age in many parts of India, in Australia, South Africa, and South America, and by ample evidence of a glacial origin for these erratics.

Returning to Calcutta in May, the Blanfords were ordered to Darjiling for the monsoon months. The next year (1857) they were separated, the younger brother being left in charge of the office then established in Calcutta, whilst W. T. Blanford accompanied Dr. Oldham during the working season 1856–7 in a survey of the Rajmahal Hills. During the latter part of the time W. T. Blanford examined the country to the westward of the Rajmahal Hills, and returned to Calcutta in May, 1857, just at the moment when the Mutiny broke out at Delhi. He had actually ridden down part of the Grand Trunk Road through the discharged sepoys of the 2nd Grenadiers, whose regiment had just been disbanded at Barrackpore, and one of the last officers he had seen in the district traversed was a few days later murdered by his men at Deoghur.

Dr. Oldham left shortly afterwards for England, where he was occupied on official work till nearly the end of the year. Henry Blanford went to Madras at the head of a Survey party, and W. T. Blanford was left in charge of the Survey and offices throughout the Mutiny year. He joined at this time the Calcutta Volunteer Cavalry Guards, a corps who were of much use in preserving the peace of mind of the residents in Calcutta, but were never called upon to take the field.

The year 1857–8 was occupied in a survey of the Orissa coast-land, but few districts in the interior of Northern India were sufficiently settled after the Mutiny to be safe for small parties to travel in. The seasons 1858–9 were mainly devoted to a complete survey of the Raniganj Coalfield, the most important source of coal in India. The ground had been previously surveyed by Mr. D. H. Williams,[1] Dr. Oldham's predecessor, but the whole of the

[1] Mr. D. H. Williams was formerly attached to the Geological Survey of Great Britain under De la Beche, and surveyed large areas of the South Wales Coalfield.

geological classification and comparison of the rocks remained to be done. The results added materially to the co-ordination of the Gondwána system, the Panchets being separated and the Damudas subdivided. The monsoon season of 1859 was spent in Southern India, chiefly in the neighbourhood of Trichinopoly, where Henry Blanford was engaged in mapping and classifying the Cretaceous system. A visit was also paid to the Nilgiris.

The report on the Raniganj Coalfield was written during the monsoon of 1860; and so was that on ironworks in Birbhum, which W. T. Blanford was instructed to examine for the Government. In November, 1860, he went to Pegu in charge of a small party to commence the survey of Burma, and the next two years were spent in the examination of the districts of Henzada and Bassein, west of the Irrawaddy. The geological results were small, the country examined consisting of Tertiary rocks with intrusive masses of serpentine in the Arrakan Hills. In 1861 a visit was paid to Mandalay and Ava in Upper Burma, then independent, and an extinct volcano, Puppa, not previously visited by any European, was found near Pagan. In Burma more attention was paid to zoology, and collections were made of the mollusca, birds, fishes, etc.; the land, fresh-water, and estuarine mollusca being subsequently described by W. T. Blanford.

In 1862 he went to England on leave, and returning to India in November Mr. Blanford was promoted to the post of Deputy-Superintendent and charged with the survey of the Bombay Presidency, the geology of which was very imperfectly known; the next four years being occupied with the survey of the Lower Nerbudda and Tapti Valleys and some adjoining areas in that Presidency and in the Central Provinces, in company with Mr. A. B. Wynne and, for a short time, with Mr. C. Wilkinson. Visits were also paid to Sind and Cutch, and to Mahableshwar, and in 1865 W. T. Blanford marched along the whole route from Poona to Nagpur in order to examine the volcanic rocks known as the Deccan traps. Amongst the principal results of the survey was the determination of the age of the Deccan traps and their relation to the Cretaceous series beneath them and the Nummulitic Series overlying them, but many other questions, scientific and economic, also received attention. The principal results of these surveys were published in the sixth volume of the Memoirs of the Geological Survey of India.

The monsoon of 1866 was spent in Calcutta, and on taking the field W. T. Blanford marched from Jubulpur to Nagpur, making a rough survey of the country from Nagpur to Sironcha on the Godávari. Returning to Calcutta in September, he was attached to the Abyssinian expedition, and left Bombay in a sailing-vessel on December 4th in company with some officers of the Commissariat. He arrived in Zoulla December 22nd, and accompanied the army to Mágdala and back, and later on spent two months in the Bogos Province to the northward. For his services on the Abyssinian expedition he was awarded a military medal.

For some years previously W. T. Blanford had paid much attention to certain branches of zoology, especially to mammals, birds, reptiles, and land mollusca, and, besides making notes on the geology, he collected largely in Abyssinia. On his return to India in October, 1868, he was engaged in working out the collections made till April, when he came to England for six months on service, and wrote the "Observations on the Geology and Zoology of Abyssinia" (published by Macmillan & Co. in 1870). Returning to India in November, he was engaged in surveying the country near Chanda, south of Nagpur, until March, 1870, when he was directed to march with his camp to Korba, 250 miles to the north-west, and examine a coal locality. Later on he marched some 250 miles further to Hazaribágh, whence he returned to Calcutta. August, September, and October, 1870 were spent on leave in Sikhim, chiefly in a journey with Captain Elwes to the Tibetan frontier north of the great peaks. Notes on the geology and zoology observed were published in the Journal of the Asiatic Society of Bengal.

The working season of 1870–1 was again spent in the Godávari Valley, and a preliminary survey was carried into the Madras Presidency near Ellore. During part of the time W. T. Blanford was engaged in selecting sites for borings in coal-bearing strata and in superintending the work which occupied him in the field till June, when he returned to Calcutta. This was the last season's work in Peninsular India. In the course of nine years he had traversed the whole peninsula on foot or on horseback, with the exception of some 20 or 30 miles, from the Arabian Sea near Surat to the Bay of Bengal at Coconada.

It was arranged that in 1871–2 the survey of Sind should be undertaken, and Mr. Blanford had already gone to Karáchi to commence work, when he was ordered to join the Persian Boundary Commission under Major St. John, R.E. (afterwards Sir Oliver St. John), to map the frontier between Baluchistan and Persia, and later on to join Sir F. Goldsmid. After a preliminary voyage in the telegraph steamer to Basra at the head of the Persian Gulf and back, in the course of which some important geological observations were recorded and large zoological collections made, Mr. Blanford came back to Gwadar, about 300 miles west of Karáchi, and thence marched with Major St. John through Jalk, Bampur, and Karman to Shiraz, travelling alone from Shiraz through Isfahan to Teheran. The journey occupied seven months, from January to August. Major St. John's party was only a portion of the Persian Boundary Commission. The principal expedition, under Sir F. Goldsmid, had met the Afghan section, under Sir Richard Pollock, in Sistan, and had travelled to Teheran, where Major St. John and Mr. Blanford joined them. A short time was spent in the Elburz Mountains, and Mr. Blanford then marched to Enzeli on the Caspian, and thence, after travelling by steamer and rail, *viâ* Astrakan, Moscow, St. Petersburg, and Berlin, he arrived in England September 19th, 1872. His health having been somewhat impaired by exposure, he remained for two years in England on leave.

During the time passed in England full reports of the proceedings of this Commission were drawn up and published in 1876 in two volumes (Macmillan) by authority of the Government of India. Mr. Blanford's contribution consisted of the second volume on the Zoology and Geology of Persia.

Blanford returned to India once more in December, 1874, and after a visit to Surat to report upon matters connected with the water-supply, he was instructed to proceed with the examination of Sind, assisted by Mr. F. Fedden of the Geological Survey. The next three seasons (1774–77) were devoted to that province, save for about three months in 1876, which were spent in two traverses of the Indian desert from Sehwan on the Indus to Jodhpur and back by Jesalmir to the Indus at Sukkur. The geological results of the Sind Survey were of great interest. Instead of only Eocene rocks being met with, as previously supposed, a series of Tertiary formations, upwards of 20,000 feet in thickness, were found to occur, and to comprise Pliocene, Miocene, Oligocene, and Eocene beds, with representatives of the Deccan traps at their base, and in one locality Cretaceous limestone with *Hippurites*. An account of the geology was published in the Memoirs G.S.I., vol. xvii.

The two following years (1877 to 1879) were chiefly spent in office work in Calcutta, the principal occupation, after completing the Sind report, being the preparation of the "Manual of the Geology of India." Mr. H. B. Medlicott had succeeded Dr. Oldham as Superintendent of the Survey in 1876, and had immediately undertaken this important work, delayed till then by Dr. Oldham's health. About half the work, which appeared in 1879, was written by Mr. W. T. Blanford. Two years (1879–1881) were passed in England on furlough, his return to India being delayed to enable him to attend the Geological Congress at Bologna in 1881 as the representative of the Indian Government. He was elected Vice-President of the Congress, and received the order of St. Maurice and St. Lazarus from the King of Italy.

Returning to India in October, 1881, he went from Bombay to Sind and on to the northern frontier of that province. For the next four months he was engaged on a rapid survey of the frontier track from Quetta to Dera Gházi Khán in the Punjab, but a severe attack of fever in March compelled him to give up work and return to Dera Gházi Khán, whence he proceeded for the last time to Calcutta. Here he found his brother, Henry F. Blanford, now at the head of the Meteorological Department. He returned to England in April, 1882, and shortly afterwards retired on pension, after 27 years' service on the Indian Geological Survey.

In February, 1883, the Council of the Geological Society of London, desirous to mark their appreciation of Mr. W. T. Blanford's services to geological science, not only by his 27 years of arduous work on the Indian Survey, but by his other contributions to geology in Abyssinia and in Persia, awarded him the highest distinction within their disposition, the Wollaston Gold Medal. In presenting it to Mr. Blanford the President, Mr. J. W. Hulke, observed:

"Your writings, which treat of a not inconsiderable portion of the Eastern Hemisphere, comprise, in addition to geology, much information respecting zoology and the climates of the countries in which you served. Stamped with thoroughness and comprehensiveness, they constitute important additions to our knowledge of these regions."

In the same month Mr. Blanford married Ida Gertrude, daughter of R. T. Bellhouse, Esq., and settled in London at 72, Bedford Gardens, Campden Hill, where he has since resided. He became a member of the Geological Society's Council in 1883, was made Secretary in 1884, and served till 1888, when he was elected President. He has continued to be a member of the Council almost continuously since, and for the last ten years he has filled the office of Treasurer. Before leaving India he was for two years President of the Asiatic Society of Bengal. He has been four times a Vice-President of the Geological Congress (Bologna, 1881; Berlin, 1885; London, 1888; and Paris, 1900).

He was elected a Fellow of the Royal Society in 1874, and has twice served, for two years each time, on the Council (in 1891–93 and in 1901–3); he has been Vice-President for three years (1892, 1901, 1902). He has also been a member of the Council of the Royal Geographical and Zoological Societies, and Vice-President of both.

In 1884 he was President of Section C (Geology) at the British Association meeting in Montreal, and on this occasion received the honorary degree of LL.D. from the McGill University. He was also in Toronto in August, 1897, and accompanied the British Association party to Vancouver Island.

Since his retirement Mr. Blanford's time has been chiefly occupied with Indian zoological work. He was entrusted by the Government of India with the editorship and control of a series of works on the "Fauna of British India," of which, up to the present time, seventeen volumes have been published, comprising the whole of the Vertebrata and several groups of insects and spiders. To this work he contributed the volume on Mammals and two volumes out of four on Birds. His principal contributions to geology during the last twenty years have been his Presidential Addresses to the geological section of the British Association and to the Geological Society. The first of these discussed some important differences between the evidence of geological age furnished by marine fossils on the one hand and that derived from fresh-water and land animals on the other. Of the two Presidential Addresses to the Geological Society, the first, delivered in 1889, discussed the results at which the International Geological Congresses of Bologna, 1881, Berlin, 1885, and London, 1888, had arrived on the very vexed subjects of the nomenclature and classification of geological formations; their faunas and floras and their geographical distribution as influenced by physical conditions; with species and mutations. In a masterly way he pointed out the many factors which have to be considered in grouping and correlating the different formations, having regard

to mode of origin, to the relation of organisms to physical conditions, and to the question of contemporaneity.

In his second address his wide knowledge of geology and natural history was brought to bear on the much debated subject of the permanence of ocean basins; and after reviewing the evidence with great skill and judgment, he concluded "that whilst the general permanence of ocean basins and continental areas cannot be said to be established on anything like firm proof, the general evidence in favour of this view is very strong. But there is no evidence whatever in favour of the extreme view accepted by some physicists and geologists that every ocean bed now more than 1,000 fathoms deep has always been ocean, and that no part of the continental area has ever been beneath the deep sea. Not only is there clear proof that some land areas lying within continental limits have at a comparatively recent date been submerged over 1,000 fathoms, whilst sea-bottoms now over 1,000 fathoms deep must have been land in part of the Tertiary era, but there are a mass of facts both geological and biological in favour of land-connection having formerly existed in certain cases across what are now broad and deep oceans."

Both addresses are pervaded by a philosophical spirit which commands our admiration, and both may be profitably read and re-read at the present day.

One who is well acquainted with Mr. Blanford and his work writes:—"As regards Blanford's views on ocean basins and old land surfaces, they have been advocated with great skill, backed by an immense experience, and seem to be in conformity with Lyellian doctrines. One important feature in Blanford's career is the way in which he has been enabled to combine geography with geology. No one can have been said to have done so much to harmonize the sister sciences, and the prominent positions he has held, from time to time, in the Geological and Geographical Societies have enabled him to give effect to his views in both connections. Together with this insight into the physical aspects of geology he combines extensive zoological knowledge, as more especially evinced by the works which he has produced or edited for the Government of India and in this country. His work in every department, whether in zoology, geography, or geology, has been marked by thoroughness and accuracy."

As already stated, Mr. Blanford received the Wollaston Medal in 1883, immediately after his final return from India, and a Royal Medal from the Royal Society in 1901 in special recognition of his work on the Geology and the Fauna of British India.

In 1904 he received from H.M. the King the Companionship of the Indian Empire.

He is an Honorary Member of the Asiatic Society of Bengal, the Hungarian Geological Society, and the American Ornithologists' Union, and a Corresponding Member of the Isis, Dresden, and the Belgian Geological Societies.

LIST OF SCIENTIFIC PAPERS BY MR. W. T. BLANFORD.

1854. "On a Section lately exposed in some Excavations at the West India Docks": Journ. Geol. Soc., x, pp. 433–435.

1856. (With Messrs. H. F. Blanford and Wm. Theobald, jun., Geological Survey of India) "On the Geological Structure and Relations of the Talcheer Coalfield in the District of Cuttack": Mem. Geol. Surv. India, i, pp. 33–88.

1859. "Note on the Laterite of Orissa": Mem. Geol. Surv. India, i, pp. 280–294.

1860. "On the Rocks of the Damúda Group, and their Associates in Eastern and Central India, as illustrated by the Re-examination of the Rániganj Field": Journ. As. Soc. Bengal, xxix, pp. 352–358.

1860–1. (With Mr. H. F. Blanford) "Contributions to Indian Malacology": Journ. As. Soc. Bengal, xxix, pp. 117–127, and xxx, pp. 347–367.

1861. "Note on the Geological Structure and Relations of the Rániganj Coalfield, Bengal": Mem. Geol. Surv. India, iii, pp. 1–195.

1861. "Note on a Species of *Plectopylis*, Benson, occurring in Southern India": Ann. Nat. Hist., vii, pp. 244–246.

1862. "Contributions to Indian Malacology, No. 3: Descriptions of new Operculated Land-Shells from Pegu, Arakan, and the Khasi Hills": Journ. As. Soc. Bengal, xxxi, pp. 135–144.

1862. "Account of a Visit to Puppádoung, an Extinct Volcano in Upper Burmah": Journ. As. Soc. Bengal, xxxi, pp. 215–226; Rep. Brit. Assoc., pt. ii, pp. 69–70.

1863. "On Indian Species of Land-Shells belonging to the genera *Helix*, Linn., and *Nanina*, Gray": Ann. Nat. Hist., xi, pp. 81–86.

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II.—On the Formation of a Species.

By John Francis Walker, M.A., F.L.S., F.G.S., etc.

THE object of this communication is to try to give a theory of what takes place when one species is changed into another. When the species A is converted into the species B there must be an intermediate transitional stage in which the collection of individuals is neither the species A nor the species B. I have already defined a species as a centre round which individuals are thickly clustered, and the spaces between these centres may be either devoid of individuals or contain here and there an abnormal form (Davidson's "Suppt. Jurassic Brachiopoda," Pal. Soc., 1876, p. 122).

This idea may be expanded thus:—The true type of a species is its centre, where the individuals are most thickly clustered and most closely resemble each other; those further from the centre differ less or more widely from the type as they approach nearer the boundary of the species.

As a species moves, either in geographical space or geological time, the position of its centre will gradually alter, if its environment be different, so that forms like those contained near the boundary of the species A, and therefore not typical of it, may become the centre of the species B and typical of it. The specimen first figured, the so-called type of a species, may be characteristic of it if it happens to be an individual near the centre of the species, but it is not so if it is a specimen near the boundary of the species; a named figured specimen is only a fixed point.

The so-called species are of unequal value; they may have been named from an abnormal form of growth, or from an immature specimen in which the characters have not been fully developed,

or from one of unusual size, or from a badly preserved specimen in which the characters are obscure. Many of the older species have been made into subgenera, and these again divided into species. The difference between a species and a variety is that the species is more permanent, being in a state of stable equilibrium.

I have stated (Davidson's "Suppt. Jurassic Brachiopoda," p. 180) that it is advisable to give a name to a well-marked variety when it is constantly found in a given geological horizon, although it may be connected by rare forms with other species, and also for the purpose of limiting the extent of variation of a form bearing the same name, so that there can be no doubt which variety is referred to when it is stated to occur in a certain district.

Species can be made to appear to have been joined together by selecting the abnormal forms out of thousands of specimens and neglecting the percentage of normal ones. The abnormal form of one species may be the normal form of another species. The true centre of a species may be found by collecting from a given locality a very large number of specimens and observing the percentage of the different forms. The greatest number of individuals closely resembling each other will indicate the centre of the species at that locality. It will be found that no two individuals are exactly alike, but the amount of variation of those which form the bulk of the collection is infinitesimal; these are the centre of the species, whilst the rarer forms differ from the typical specimens, and are therefore further from the centre of the species. The conversion of one species into another must be gradual, as a sudden change would probably make the species extinct, as it would require time to adapt itself to the conditions which alter its form. Great and sudden alterations in form tend to weaken an individual so that it seldom survives; this serves to check rapid variation.

The tendency of variation in a species is also checked by their interbreeding with each other, and probably the power of variation during a limited time is not great without exhausting the species. The susceptibility to the influence of environment will vary in different individuals: some will be able to alter their form and adapt themselves to the new conditions, others will scarcely be able to alter and will become gradually extinct.

The rate of variation in individuals may be different, and give rise to new species: thus, the species A may develop two or more points nearer its circumference where individuals differing from the typical form begin to thickly cluster, and so give rise to new centres, the percentage of the normal form of the species A becoming gradually less; these centres, if isolated from each other, will give rise to new species. The spaces between different centres of species are unequal, owing to missing species which have not yet been discovered.

The duration of the life of a species will depend on the length of time it exists under the same conditions; the longer it does so the less it will vary, as it will have gradually acquired the most favourable form for its environment, and therefore all variations

will be less favourable and have less chance of surviving. This will account for the greater length of time the Palæozoic species existed compared with the Mesozoic species, as the seas would have greater extent and be less broken up by land.

III.—Rock Cavities in Granite in Madagascar.

By the Rev. Richard Baron, F.L.S., F.G.S., Tananarive, Madagascar.

I WAS much interested in the account of the 'erosion' of rocks in Corsica given by Mr. Tuckett and Professor Bonney respectively in the January and August numbers of the Geological Magazine for 1904, more especially as I have been long acquainted with similar phenomena in Madagascar, and have, equally with the authors mentioned, been long puzzled to find an explanation of their origin at all satisfactory.

Perhaps a brief statement of the occurrences of such rock 'erosion' in the form of cavities as I have met with in Madagascar may be worthy of a place in the Magazine, as being another small contribution to the subject.

I shall first of all give, in very few words, a description of the rock in which the cavities occur, and then proceed to a short account of a few of the most striking of the cavities themselves.

The rock (apparently a boss) in which these cavities occur is porphyritic granite, occupying, roughly speaking, a circular area of, say, fifteen or sixteen miles in diameter, and weathering, as granite usually does, into small and large, more or less rounded or oval-shaped hills, which are scattered all over the surface. The western edge of the mass is some ten or twelve miles to the east of Antananarivo, the capital of the island.

The rock is, strictly speaking, a porphyritic hornblende-granitite (i.e. hornblende-biotite-granite). In colour it is grey, blotched, and streaked with black. Fully three-fourths or four-fifths of its bulk is felspar. This occurs in the form of porphyritic crystals, the longest of which attain sometimes two inches in length. The felspar includes orthoclase-microperthite (pure orthoclase is apparently quite absent, or at any rate rare), microcline, and another plagioclase (? oligoclase); these exist in not very unequal proportions. The felspars often show the central accumulation of extremely minute dusty particles, more frequently seen perhaps in more basic rocks (gabbros and norites especially). Micropegmatite, as well as ordinary quartz-felspar mosaic, occurs as a coating round some of the grains. Both the felspar and the quartz (the latter with abundant planes of gas and liquid inclusions) show signs of some amount of molecular strain. The mica is ordinary brown biotite, and the amphibole ordinary green hornblende. These occur in irregular flakes and grains, but are often so intimately associated as to lead to the supposition that the one has been derived from the other.

As accessory minerals, occur sphene (pretty abundant), magnetite (often intergrown with iron pyrites), apatite, zircon, and calcite, possibly also a few minute garnets.

The porphyritic felspars often show a slight fluxional arrangement. The rock, except superficially, is quite fresh, and at the localities where the cavities occur the weathering has not proceeded further, neither in depth nor degree, than in other places.

The above is a brief description of the granite in which the cavities to be described are found. It must be remembered, however, that many more cavities are known than those here mentioned, and that all these together doubtless form but a very small fraction of those which exist throughout the granitic area.

The first hole I shall describe is situated in the middle of a perpendicular face of rock some two-thirds of the way up one of the high hills close by the village of Alarobia. The lower edge of the hole is 8 or 10 feet above the foot of the rock, and cannot be reached without the aid of a small ladder or other contrivance. The rock at its surface is somewhat weathered, but not more so than in other places. The entrance is nearly round, and some 5 or 6 feet in diameter. Inside, from the roof downwards, the hole measures 12 feet, the width is 10, and the depth inwards and horizontally from the entrance is 9. It is in part divided into two portions by a projecting ridge; these two portions are together roughly separated into eight rounded divisions; and these again into some three dozen smaller ones, the average being more than sufficient to contain a man's head. The walls are not smooth, and not specially weathered; in fact, they are much the same as the rock outside. A white powder may be seen here and there on the surface, which, possessing an alkaline taste, may be a potash salt derived from the felspar.

At the foot of the hill there is a fallen rock, in the face of which are two holes, each about the size of a very large straw beehive.

Another hole is to be found on the east side of the mountain of Ambohibory, about half-way up. The entrance is about 4 ft. high by 2 ft. 6 in. in width, and of a rounded shape, like that of the large cavity mentioned above. The interior measures 5 ft. 2 in. from the roof downwards; from the mouth inwards to the back is 4 ft.; the direction at right angles to this being 4 ft. 10 in. The wall of the cavity contains thirteen or fourteen rounded depressions.

On the same hill, a little farther south, is to be found another but smaller cavity. Its dimensions are as follows: height 1 ft. 6 in., horizontal diameters 3 ft. by 3 ft. 10 in. There are two entrances near to each other, one 2 ft. 4 in. wide by 1 ft. 9 in. high, the other 1 ft. wide by 1 ft. 6 in. high. In the interior there are three or four nest-like depressions.

Not far away, on the same side of the hill, there is another cavity having a comparatively small entrance (about 2 ft. by 2 ft.). The height of the interior is about 3 ft., its breadth from right to left 2 ft., and its depth from the mouth inwards 5 ft. 5 in. In the wall are six or eight smaller cavities.

There is another hole a few yards further south on the under side of an overhanging mass of granite. Though it is small, it

contains three or four basin-shaped depressions. Other cavities exist further south.

On the mountain of Ambohitsileo there are several other cavities, one of which is probably larger than any of those mentioned above.

On the north side of the mountain of Angavokely there is also a large cavity.

It stands to reason that if in the course of two or three comparatively short rambles so many rock cavities should be found, a further acquaintance with the granitic area would probably reveal the existence of others in large numbers.

How, then, are these rock-holes to be accounted for? I have known of their existence for many years, but they had practically passed out of my mind until I came across the articles in the GEOLOGICAL MAGAZINE for 1904. The explanation of their formation which always occurred to me when I thought about them was that they represented what were originally nests of felspar, which had since decayed and disappeared. I have, however, always felt the explanation to be unsatisfactory, and for the following reasons:—(1) Though segregations of the more basic minerals (often taking the form of true diorite) are quite common in the granite, segregations of felspar (except here and there in veins) I have never come across. I do not, of course, say that there are none such. (2) Felspar nests can hardly be supposed to have had in all cases the remarkably rounded outlines and the rounded protuberances on the surface which the cavities, such as I have described, seem to require. (3) If these holes really represent nests of felspar which have rotted out and disappeared, it is difficult to account for the felspar crystals on the present walls of the cavities remaining comparatively fresh; and (4) it is difficult to see by what process, on this supposition, the decayed felspar has been so cleanly scooped out of the holes.

The theory that these numerous cavities have been eroded by the action of wind-carried sand cannot possibly account for them, at any rate in the area I am speaking of, for the simple reason that there is no sand anywhere near worth speaking of, and sand-laden winds are unknown in the interior of the island. Moreover, would not sand-abrasion produce striæ round the walls? The theory on the face of it seems far-fetched. Abrasion of plain surfaces by blown sand in the open country is quite explicable, but that the sand-laden wind (supposing sand to be present) should gyrate and bore at particular points sufficiently long or frequently to produce these remarkable cavities seems to me entirely incredible.

"Nor," as Professor Bonney says, "does the action of dew or of moisture in any form seem a promising explanation, for," etc.

If, then, these rock cavities are due neither to the decay and disappearance of knots or nests of felspar, nor to erosion by blown sand, nor to the action of "dew or moisture in any other form," how are they to be accounted for?

I make bold to suggest an explanation, to which at present I can see no objection, and which, at any rate, would account for the phenomena; it is *that these cavities represent spaces occupied by*

imprisoned vapours in the original rock magma. We know what an important rôle the occlusion of gas and liquid bubbles plays in individual minerals; to how large an extent bubbles, many of them gigantic, of steam and other gases rise from the depths to the surface during volcanic activity; and how also solidified lava is frequently riddled with rounded vesicles, the former receptacles of imprisoned gas. Is it therefore improbable that the hot vapours in certain deep-seated magmas, instead of being entirely absorbed, have, in certain parts and under certain conditions, so pushed aside the viscous mass by their expansive force as to form larger or smaller vesicles? And, further, is there any reason against the supposition that some of these spaces have been occupied by several bubbles, for a time at least, in juxtaposition, though separated probably by partitions of the magmatic material? The existence of protruding ridges (which are sometimes present) would seem to support such a view, the remaining walls having broken down and disappeared. If this hypothesis be correct, it would seem to follow that these gas cavities, or some of them, must have existed during at least the closing stages of the solidification of the rock; in other words, from the time that the rock was still sufficiently viscous to permit of being pushed aside by the expansive power of the vapour, until it had hardened to a degree sufficient to prevent the collapse of the walls of the cavities. Whether previously the whole of the gas was equally dispersed throughout the rock mass, or whether part of it had accumulated here and there into bubbles, I do not pretend to say. The diminution of pressure during the final stages of solidification would probably also allow of the increased expansion of the imprisoned gases. It would also follow that, as denudation proceeded at the surface of these rock masses, fresh cavities should continually come to the surface, and that this is the case seems to be shown by the smallness of the entrance to some of the holes (Professor Bonney speaks of one only two inches in diameter),[1] entrances which would naturally widen until the hole would become more or less basin-shaped, and finally disappear.

What are the miarolitic spaces and drusy cavities which not unfrequently are to be found in plutonic rock masses? Are these in every case due to contraction on crystallization of the rock material, or may they not be sometimes owing to the expansion of localized vapour? If the latter, these rock cavities may be nothing more than miarolitic spaces or druses.

It is in consequence of the improbability of the production of these rock cavities by any form of superficial action suggested or apparently conceivable that I have been led to the above hypothesis as their efficient cause. What are the objections to it?

[1] Mr. Baron has forgotten that this little hole was merely one of communication between two adjacent cavities, the inner of which had one of ordinary size lower down.—Ed. Geol. Mag.

IV.—Weathered Dolerite of Rowley Regis (South Staffordshire) compared with the Laterite of the Western Ghâts near Bombay.

By Dr. Hugh Warth.

SINCE it has been proved that large areas of basaltic and other igneous rocks within or near the Tropics in India, on the Seychelles, and in Australia yield surface deposits (so-called Laterites) identical with Bauxite, it is of great importance to ascertain exactly what products of decomposition or weathering originate from corresponding rocks in a temperate climate.

My attention was drawn by Professor W. W. Watts to beds of weathered rock which overlie the Dolerite of Rowley Regis. These beds are about 20 feet in thickness and ochre-coloured. The material is so soft that it is easily crushed between the fingers, whilst its mineralogical composition and its mode of occurrence leave no doubt as to its having been formed *in situ* from the Dolerite. I therefore decided to analyse this product. The following table contains the result:—

Column i of the table represents the composition of the original Rowley Regis rock, which was obtained as the average of three analyses, two of them by J. H. Waller[1] and a third analysis by Henry.

Column ii, the weathered product of Rowley Regis (steam dry).

Column iii, composition of Dolerite from Poonah on the Western Ghâts in the Bombay Presidency (analysed by my son F. J. Warth, M.Sc.).

Column iv, the composition of the Laterite which rests on the Dolerite at Mahabaleshwar, which is also situated on the Western Ghâts (see p. 155, Dec. IV, Vol. X, of this Magazine, April, 1903, by H. & F. J. Warth).

	Rowley Regis.		Western Ghâts.	
	I.	II.	III.	IV.
SiO_2	49·3	47·0	50·4	·7
TiO_2	·4	1·8	·9	·4
P_2O_5	·2	·7	—	—
Al_2O_3	17·4	18·5	22·2	50·5
Fe_2O_3	2·7	14·6	9·9	23·4
FeO	8·3	—	3·6	—
MgO	4·7	5·2	1·5	—
CaO	8·7	1·5	8·4	—
K_2O	1·8	2·5	1·8	—
Na_2O	4·0	·3	·9	—
H_2O	2·9	7·2	·9	25·0
Total	100·4	99·3	100·5	100·0

This table shows the striking difference between the weathering of the Rowley Regis Dolerite and that of the Dolerite of Poonah, which so far may represent the whole of the Deccan Trap. Whilst

[1] For one of these two analyses see Teale's Petrology; the other being unpublished, Mr. Waller kindly permitted me to make use of it.

the Rowley Regis Dolerite yields a product (column ii) which differs comparatively little from the original rock, this Dolerite of the Western Ghâts is altogether changed into a mixture of aluminium hydrate and ferric oxide, the most remarkable fact being the nearly perfect removal of the silica in the latter case.

For a further test I levigated a sample of the Rowley Regis product very carefully by suspension in water, and I obtained about 10 per cent. of the whole as a very fine ochre-coloured powder. The composition of this fine powder steam-dried was as follows :—

$Si O_2$	48·3
$Ti O_2$	·5
$P_2 O_5$	·8
$Al_2 O_3$	22·9
$Fe_2 O_3$	11·6
$Fe O$	tr.
$Mg O$	1·4
$Ca O$	3·8
$K_2 O$	2·4
$Na_2 O$	1·6
$H_2 O$	6·8
	100·1

There is no essential difference between this fine matter and the entire weathered product, column ii of the table. Comparing the weathered product with the fresh Rowley Regis rock, we find that the process of weathering has resulted in the removal of far more basic substance than of silica. There is no tendency towards the formation of a Bauxite, but rather towards that of a clay. The relation is the same as indicated in a few other cases by Merrill, pp. 215, 216, and 223 of his work on Rock-weathering. Merrill was able to illustrate even a complete change into clay in one or two instances, and we may safely conclude that the ultimate product of the Rowley Regis rock would also be a complete clay. Anyhow, this Rowley Regis product represents altogether a different transformation from that which took place in India.

No chemical reaction is known which can account for such a complete removal of silica as has occurred in India, neither is there any explanation why such a reaction should work in India and not in England. The only hypothesis we have is the one based on Mr. T. H. Holland's novel and ingenious suggestion [1] that the silica might be rendered soluble by lowly organisms which can thrive in the uniformly warm climate of the Tropics, and not in a region of lower and varying temperature. However, there is as yet no actual proof for this hypothesis, and under the circumstances it may not be inappropriate once again to draw the attention of chemists to this remarkable phenomenon in case there might after all be a strictly chemical solution of the problem.

There is one point which requires still to be mentioned. In the above it was assumed that the surface deposits of Laterite (or Bauxite)

[1] T. H. Holland on the Constitution of Laterite, Geological Magazine, Dec. IV Vol. X, February, 1903, pp. 59–69.

originated *in sitû* from the Dolerite. This view, however, is not shared by all observers. Some eminent geologists consider the high-level Laterite of the Western Ghâts as a derived, viz. transported, rock. If such were really the case we should only be brought face to face with another difficulty almost as great as the former. We should have to explain why and how in particular regions such vast quantities of ferric oxide and alumina were extracted from the igneous rocks, and both bases redeposited together without any admixture of other substances except mere traces of silica and titanium dioxide.

NOTICES OF MEMOIRS, ETC.

Brief Notices.

1. Recent Discoveries in Madagascar.—The first trimestrial number of this year of the *Bulletin Economique* of Madagascar and Dependencies contains a preliminary notice by Mr. Standing on the discovery of sub-fossil bones at Ampasambazimba (west of Lake Itasy).

A great number of bones, which were found embedded partly in a travertine and partly in a black "basaltic or peaty" soil, have already been received by the *Académie Malgache* of Tananarive. Besides fragmentary remains of *Hippopotamus*, Crocodiles, Chelonians, and *Æpyornis*, there are several beautifully preserved skulls and fragments of jaws and limb-bones of extinct Lemuroids, a description of which will be given in the Bulletin of the *Académie*. All the known groups of sub-fossil Lemurs are represented in the collection.

The *Megaladapis* 'group' is represented by the anterior part of a skull of *M. madagascariensis* and by several fragmentary jaws.

The remains of *Palæopropitheci* are numerous, comprising two fine skulls of a new species, together with other less complete skulls, lower jaws, and a femur.

The *Archæolemur* or *Nesopithecus* group is likewise well represented.

Of the Lemurs *sensu stricto*, two skulls deserve particular mention, the one resembling the recent *Lemur varius*, the other the extinct *L. insignis*.

Last, but not least, a fragmentary lower jaw is said to be of particular interest, as throwing light on the origin of the Aye-Aye (*Chiromys*).

2.—L. Dollo. Les ancêtres des Mosasauriens. (Extr. from Bull. Scientif. de la France et de la Belgique, 1903, vol. xxxviii, pp. 1–3.)

In his memoir "Über die Varanus-artigen Lacerten Istriens" (Beitr. zur Pal. und Geol. Oesterreich-Ungarns und des Orients, 1903, vol. xv, p. 41)[1] Baron Franz Nopcsa, jun., arrives at the following conclusions:—

a. The Pythonomorpha are derived from the Aigialosauridæ.

[1] See Geol. Mag., 1903, pp. 119–121.

b. The Aigialosauridæ show already adaptations to aquatic life in the structure of the foot.

c. Aigialosauridæ and Varanidæ have for common (Jurassic) ancestors terrestrial Reptilia, which therefore must have had an organization very similar to that of the Varanidæ.

M. Dollo claims priority for these results by referring to pp. 259 and 251–259 of his memoir of 1892, "Nouvelle Note sur l'Ostéologie des Mosasauriens" (Bull. Soc. Belg. Géol., Paléont., et Hydr., Bruxelles, 1892, vol. vi, pp. 219–259, pls. iii, iv).

3.—L. Dollo. Les Mosasauriens de la Belgique. (Bull. Soc. Belg. Géol., Paléont., et Hydr., Bruxelles, 1904, vol. xviii, pp. 207–216, pl. vi.)

Contains some new observations on the Mosasaurians. The following remarks on the difference between *Mosasaurus* and *Plioplatecarpus* are of especial interest:—

Mosasaurus—by its strong dentition, its lateral orbits, its thin tympanic membrane, by the absence of a median basi-occipital canal, by its elongate thorax, the powerful caudal fin, and the small anterior fins—is shown to have been a *swimming Mosasaurian*, living near the surface, and enabled to capture, while swimming, the formidable creatures which formed its prey.

Plioplatecarpus—by its reduced dentition, its upward turned orbits, its calcified tympanic membrane, its median basi-occipital canal, its short thorax, its feebly developed caudal fin, and its strong anterior fins—is shown to have been a *diving Mosasaurian*, descending to more or less considerable depths, and feeding on small creatures.

4.—L. Dollo. L'Origine des Mosasauriens. (Bull. Soc. Belg. Géol., Paléont., et Hydr., Bruxelles, 1904, vol. xviii, pp. 217–222.)

The author's conclusions are as follows:—

a. Boulenger was the first to point out the relationship between the Dolichosaurians and the Mosasaurians.

b. Gorgjanovic-Kramberger has given an important contribution by his description of *Aigialosaurus*, and by recognising that the Aigialosauridæ are ancestral to the Mosasaurians. He has, however, imperfectly appreciated the phylogenetic position of the Dolichosaurians.

c. The author's memoir of 1894, "Nouvelle Note sur l'Ostéologie des Mosasauriens," based on original, inedited materials, gives for the first time the real relations between the Lacertilians, the Dolichosaurians, and the Mosasaurians. For the first time also the Dolichosaurians are shown to be *genealogically* intermediate between the Lacertilians and the Mosasaurians.

d. Williston is mistaken in assuming (Journal of Geology, 1904, vol. xii, p. 45) that Boulenger and Dollo have simply adopted the views of Gorgjanovic-Kramberger.

5. The Rhætic Bone-beds.—Mr. W. H. Wickes has published in the *Bristol Naturalist's Society's Proceedings* (x, pt. 3, 1904) an interesting and important communication on the Rhætic Bone-beds.

His summary reads as follows:—The 'Bone-bed' is not a regular or persistent bed, but a series of thin sheets (or lenticules) of varying extent, coming in at various horizons and deposited at various times. These sheets are separate and have no connection with each other, except that they are of common origin, the general structure and fossils being identical. They are chiefly caused by the Saurians and carnivorous fishes, being the remains of their victims, with the addition of coprolites, etc. The extent of each sheet was determined by the size of the shoal, and the thickness *by the time it remained at that station.* At intervals the *shoal shifted* to another station, where the process was repeated and another Bone-bed formed. Owing to deposition of sediment, each successive bed was on a higher horizon than its predecessors. These are original organic deposits *in sitû, and not drifted material.* They may be summed up as submarine guano beds laid down by the floating population of the period. We must refer the reader to Mr. Wickes' paper for the details of this highly suggestive piece of work, but may mention that the pebbles in these beds are attributed to fishes, for which idea a good deal of interesting evidence is brought forward.

6. The Kimeridgian in East Prussia.—The thick covering of drift materials so extensively spread over the flat country of the north-east of Germany very effectually conceals the solid rocks beneath, and to ascertain their nature it is necessary to resort to boring. Near Heilsberg, in the centre of the province of East Prussia, a boring has been carried down to a depth of over 600 metres below the surface, and it resulted in the discovery of rocks of Kimeridgian age at a depth of 562 metres. Dr. P. G. Krause has undertaken the examination of the cores, and in a preliminary communication in the Zeitschrift d. deutschen geol. Gesellsch., Bd. lvi (1904), p. 56, he states that the rock is a light-gray, fine-grained sandstone with a small admixture of lime and clay. It contains *Cardioceras Volgæ,* Pavlow, very numerous, *C.* cf. *subtilicostatum,* Pavlow, *C.* n.sp., *Hoplites subundoræ,* Pav., *H.* n.sp., *Aspidoceras acanthicum,* Opp., *A.* cf. *Karpinskii,* Pav., *Exogyra virgula,* Goldf., and species of *Astarte, Pecten, Protocardium, Thracia,* and *Trigonia.* The Ammonite fauna shows a very close resemblance to that described by Pavlow in the *Acanthicus*-zone of the Volga district of Eastern Russia. Below 600 metres the *Cardioceras*-forms disappear, and thus the Kimeridge beds in this locality would appear to be not more than 38 m. in thickness.

7. Foraminifera and Ostracoda from the Cretaceous of East Pondoland, South Africa.—In the Annals of the South African Museum, vol. iv, pt. 5, F. Chapman describes and figures 18 species and varieties of Foraminifera and 7 species and varieties of Ostracoda from a greenish argillaceous and sandy rock of Cretaceous age from East Pondoland, Cape Colony. The foraminifera belong to the following genera: *Haplophragmium, Bulimina, Pleurostomella, Nodosaria, Vaginulina, Cristellaria, Polymorphina, Globigerina,*

Truncatulina, *Pulvinulina*, and *Rotalia*. Fifteen of the 18 species are already known from the Cretaceous and Tertiary strata of this country and Germany; they are all such as would be found in quite shallow water. Of the Ostracoda, one doubtful form is of Oolitic age, 4 occur also in the Cretaceous rocks of this country, whilst 2 are described as new. The author states that the general facies of these Microzoa indicates a position intermediate between the Lower and Upper Cretaceous series.

8.—Geology of the Transvaal, by Dr. G. A. F. Molengraaff. Translated from the French by J. H. Ronaldson, M.E. With Additions and Alterations by the Author. Royal 8vo; pp. viii. 90. 19 figures; pl. i, Geological Sketch Map; pl. ii, Geological Sections. (Edinburgh and Johannesburg, 1904.)

This memoir appeared originally in the Bull. Soc. Géol. de France, 1901, and a notice of it was given in the October Number of the Geol. Mag. (p. 475) of the same year. The translator states that the English edition has been undertaken in the hope of bringing it within the easy reach of many busy men. The author has added a new chapter and corrected and augmented the others, and a list of the principal works of reference, brought down to the present year, is appended. This general sketch by a geologist so capable and experienced as Dr. Molengraaff may safely be commended to all who are interested in the geological structure of the Transvaal.

REVIEWS.

I.—Memoirs of the Geological Survey of England and Wales. Sheets 355 and 356: Geology of the Country round Kingsbridge and Salcombe. By W. A. E. Ussher, F.G.S.

THIS memoir is a very interesting and valuable contribution to the geology of Devonshire, although the area thus mapped and described is limited in extent. The bulk of the rocks consist of Devonian slates, etc., bordered on the south by the Metamorphic schists of the Salcombe estuary (Start and Bolt rocks). Within the area, likewise, are one or two remnants of New Red rocks, whilst the phenomena of Pleistocene and Recent deposits, including modern beaches, afford much material for study and investigation. Yet the chief interest of the memoir centres in the description of the Devonian and Metamorphic rocks, and in their relation to each other along a boundary which extends from sea to sea.

In these days of thorough research, when there would seem to be so little left for posterity to accomplish, it is some consolation to find that even within the limits of a single English county there are yet problems in its geological history which cannot be said to have been altogether solved. Amongst these questions still *sub judice*, there are few more interesting and perhaps none more obscure than the true

relations of the crystalline rocks of Salcombe to the Lower Devonian rocks on their northern margin. As remarked in the preface by the Director of the Survey, "the age of the schists is left undecided by the author, though more definite views on the subject have been expressed in favour of their antiquity by Professor Bonney and Miss Raisin, and in favour of their being metamorphosed Devonian rocks by Jukes & Holl, A. Somervail, and A. R. Hunt."

It may well be supposed that there has been an extensive literature on this subject, and on p. 42 a summary of the principal works is given. Commencing with De la Beche, the father of the Geological Survey, our author observes that he approaches the subject with characteristic caution. There appears to have been a belief in some quarters that De la Beche favoured the notion that the Metamorphic schists were altered Devonian rocks. Yet his views as enunciated in his classical "Report on the Geology of Cornwall, Devon, and West Somerset," though by no means dogmatic, are strongly in favour of their entire independence of each other.

The following is the concluding passage of his chapter on the Mica Slate, Hornblende Slate, and Associated Rocks:—"Although there may be some obscurity as to the mode in which the red and grey argillaceous slates on the north come into contact with the mica and chloritic slates, the line which separates them from each other may be considered as well marked. There appears no passage from one into the other which would authorize the supposition that both were merely portions of a larger mass, one having been exposed to different conditions from the other, subsequently to their original formation, by which its first mineral character became changed. Neither does there appear any mode in which we could consider the one portion to have been buried beneath detrital accumulations and then changed, according to the hypothesis above noticed, without the adjoining mass having been subject to like conditions. If the one be an altered portion of a larger mass, of which the other constituted a part, it could scarcely have been by this process. In the absence of any contradictory evidence, it would appear fair to infer that these rocks [the mica slate, hornblende slate, etc.] belong to that class which is more ancient than the grauwacke series; and though the mica and chloritic slates of the district may be associated with rocks possessing an arenaceous aspect, even supposing they may be detrital, that they form no part of that series which adjoins them on the north." Moreover, it is important to observe that, in the explanatory column of his Index-map, the colour by which the Metamorphic series is indicated bears the legend "Chlorite Slate and Rock, Mica Slate and Gneiss."

So far, therefore, as the publications of De la Beche himself are concerned, there is nothing whatever to indicate that he favoured the hypothesis of metamorphosed Devonians, which, as we have seen, he regarded as by no means a likely solution of the problem. Yet we are confronted with this difficulty, viz., that on the old Geological Survey map the boundary between the two series is indicated, for the most part, by a faint, dotted line, and the rocks

of the southern area, under the symbol κ, are marked in the index of colours as "Altered Devonian." This old map bears the Ordnance Survey date of 1809, but we have not seen a copy wherein the date of the geological information is engraved, neither are the names of the surveyors indicated. This is the more unfortunate because there is a marked difference in the boundary-line as shown on the old and new maps respectively, so that it would have been satisfactory to ascertain who was really responsible for having included such a considerable outcrop of undoubted Devonian rocks within the Metamorphic area in the direction of the east coast. Mr. Ussher duly notices this in his memoir, and suggests that, whilst from the Kingsbridge estuary to the west coast at Hope, "the boundary is shown with sufficient accuracy to lead one to infer that it was traced on the ground," yet that in the eastern district the boundary-line was based on conjecture. This explanation is certainly not very complimentary to the early geological surveyors.

There is more in this old inaccuracy than, at first sight, meets the eye; because if the Tinsey Head beds were included in the series of the crystalline schists, such inclusion might seem to favour the notion of progressive metamorphism, which has been a cherished hobby with some of the local geologists, but which is not, so far as the present memoir goes, favoured by Mr. Ussher. His views on this point are particularly recorded in his Report of the recent Excursion of the Geologists' Association (Proc. Geol. Assoc., vol. xvii, p. 125), where he speaks of "the entire absence of any appearance of progressive metamorphism in the Devonian rocks approaching the boundary." It would be satisfactory, therefore, to ascertain who was responsible for colouring the Metamorphic Rocks in the old Survey map as "Altered Devonian," and how far this arrangement was agreeable to De la Beche in the face of his published statements to the contrary. There was, we are well aware, a period in the history of the Geological Survey when it was the fashion to regard crystalline rocks of unknown age as the altered representatives of formations recognized in the district. This was markedly the case when the Anglesey schists were regarded as altered Cambrian. Since we are unable to assign a date to the appearance of the old Geological Survey maps of South Devon it is not easy to pursue this subject further.[1]

The two sheets of which Mr. Ussher's memoir is explanatory were published in 1898 from resurveys by the author; they mark a considerable improvement on the old Survey maps. Thus the line between the Devonians and the Crystalline Schists is for the most part clearly indicated, and the schists themselves are separated into two distinct series, viz., the mica-schists and the green or hornblende-epidote-schists, each series being shown by a different

[1] We have reason to believe that the Kingsbridge area was surveyed by De la Beche. His field maps show two distinct divisions in the metamorphic area, otherwise the geological boundaries are as in the published map, *Old Series*. It should be observed that there is nothing here to connect De la Beche with the notion of metamorphosed Devonians. The responsibility for this has yet to be disclosed.

colouration. An attempt has also been made to differentiate the Devonians amongst themselves, and the Director announces that an approximate boundary will be shown, in a future edition, between the Dartmouth Slates and the overlying Meadfoot group.

In the introduction to the memoir Mr. Ussher gives a table of the rocks in the district, which, as regards the Devonians and Metamorphics, may be abridged as follows:—

DEVONIAN OR NORTHERN AREA.

Group.	*Local Subdivisions, etc.*
Meadfoot and Looe Beds	Tinsey Head Slate Series. Beeson Grits. Torcross type. Ringmore type.
Dartmouth Slates	Glossy, green, purple, etc., slates (constituting the lowest beds).

Some of the above series contain a certain amount of igneous rocks, the basic predominating.

METAMORPHIC OR SOUTHERN AREA.

Altered Sedimentary Series ...	Mica-schists, quartz-schists, interbedded mica-schists, and quartz-schists.
Altered Basic Rocks	Green schists or hornblende-epidote-schists (presumably the higher series).

Devonian or Northern Area.

The structure of these rocks is described in the introduction. They are subject to a general east and west strike, though affected by frequent small plications, which tend to obscure the larger curves, and thus local strikes are often at variance with the general strike. In interlaminated hard grits and shales the planes of schistosity are generally bedding planes; in the argillaceous rocks they are mostly due to cleavage with which bedding accidentally coincides; gnarling is more especially noticeable in hard grit-shales or interlaminated beds: the effects of gnarling and other structural phenomena are illustrated by cuts in the text. The schistosity dips of the Devonian rocks are mostly at high angles, ranging from 60° to 90°. In three traverses taken from the Metamorphic boundary to the margin of the maps it may be noticed that the dips are either northerly or vertical in the immediate vicinity of the boundary-line, the reverse or southerly dips only occurring at some distance therefrom.

When we come to the distribution of the Devonian rocks within the area much depends upon the interpretation of an obscure stratigraphy, which has been only too fruitful of divergent opinion, though we may express a hope that the true sequence has at length been revealed to Mr. Ussher. The key of the situation seems to consist in an anticlinal of Dartmouth Slates, the lowest Devonian horizon of this district, which throws off the equivalents of the Meadfoot group on the southern wing of the anticlinal. It is with this southern wing that we are chiefly concerned, since it comprises the principal Devonian series of the district right up to the Metamorphic boundary.

The Dartmouth Slates within the area are by no means an interesting formation, traces of limestone being very rare, so that there is no reason to wonder at the lack of fossil evidence. Igneous rocks are "very occasionally" met with, some of which may be in part contemporaneous. The absence of organisms seems to be the chief distinguishing feature of these basal rocks, so that where traces of crinoids, brachiopods, or corals occur the presumption is against such strata belonging to the Dartmouth Slates.

The Meadfoot group is far more interesting, and, as its members occupy the principal portion of the Devonian area between the suggested anticline and the Metamorphic boundary, the entire series may be taken as the typical representative of the Lower Devonian in the Kingsbridge–Salcombe peninsula. The following are the divisions adopted, as we have seen, by the author, in ascending order, viz.: the Ringmore Type, the Torcross Type, the Beeson Grits, and the Tinsey Head Slate Series. Judging from the Director's preface, it would appear that when the new maps (sheets 355 and 356) were published in 1898 Mr. Ussher had not then established the fact that the Devonian rocks on the south of the Dartmouth Slates "are parts of the Meadfoot series, and correspond to the types met with in that series in the Looe, Plymouth, and Long Sands (south of Brixham) coast series" (p. 56).

Dealing briefly with the four above-named series in ascending order, we find that there is a considerable amount of brown-coloured fossiliferous material in beds of the Ringmore type, though actual limestone is seldom discernible in the inland localities. Crinoidal limestone films and lenticles, often red-stained, are met with in certain localities, and well-known Lower Devonian genera may be recognized with more or less certainty in these crushed calcareous films, though too often flattened out beyond specific recognition. On the whole, these beds must have originally included a fair amount of organic remains, and at Ringmore itself, in about two feet of glossy and variegated shales, were found flattened impressions resembling *Spirifera primæva*, *Streptorhynchus gigas*, and *Zaphrentis*; also the eye of a large trilobite, possibly *Phacops latifrons*. This seems to be about all that can be done in the way of palæontology, though doubtless the beds have been subjected to careful search for fossils.

The rocks of the Torcross type are chiefly remarkable for numerous thin bands of igneous rock, generally much decomposed, associated with the slates; in some cases these igneous rocks may be contemporaneous, though their appearance on the map is more suggestive of dykes, especially the long one at the Torcross end. Certain developments of grit, south of beds of the Torcross type, have been termed Beeson Grits, and these are shown on the map by a deeper colour. Amongst the alternative hypotheses, presently to be considered, is the possibility that these Beeson Grits constitute an anticline, so that the Torcross Slates on the north are carried over on the south of these grits. It is not easy to perceive which hypothesis most commends itself to the author, but on the supposition

that the Beeson Grits merely represent an outcrop, the next series on the south, viz. the Tinsey Head Slates, must be regarded as the highest in the local Devonian sequence.

This last-named series is interesting from the fact that its southern limit is well-defined by the 'brown rocks' which border the hornblende-epidote-schists (Metamorphic group), and which limit is also more or less easily determinable, west of the Kingsbridge estuary, where the slates are in contact with the mica-schists of the Metamorphic group. It will be remembered that a considerable portion of this series to the east of the estuary was included, in the old Survey map, with the Metamorphic rocks. The author now includes with this series the "interlaminated argillaceous, calcareous, and siliceous beds" of Tinsey Head, previously grouped by him with the Beeson beds; these contain seams of crinoidal limestone, and even *Zaphrentis* has been found in the Southpool section. He also remarks that the absence of igneous rocks in these beds supplies a further argument against their correlation with those of the Torcross section.

We may observe that the so-called "Tinsey Head slate series" derives its chief interest from the fact of its being that portion of the Devonian system which is in contact, all along the line, with the Metamorphic rocks. In the days when the doctrine of progressive metamorphism appeared to find favour, the petrography of the various members of this series was the subject of much study. Even now the Director tells us (p. 25) that the mechanical structures of a much puckered rock from Tinsey Head are precisely those seen in the quartzose mica-schists. Doubtless the mica-schist section of the Metamorphic rocks represents a series of arenaceous and argillaceous deposits which may be matched by rocks occurring in the Devonian area. It would be strange if it were not so, when individual fragments of each are selected for comparison. Since, however, Mr. Ussher tells us that the boundary of the Tinsey Head slate series is well-defined, this can only result from an entire and obvious contrast in the aggregate of the rocks on either side the boundary. Doubtless he has done well to oppose the application of the doctrine of progressive metamorphism in this case, but his resources are not yet exhausted, and he has a second string to his bow, as we shall perceive in the sequel.

Metamorphic Rocks or Southern Area.

The rocks of this area, he says, present two well-marked stratigraphical groups—the green schists and the mica-schists. Of these two groups the green schists are believed to be the uppermost. "The mica-schists undoubtedly represent a series of sediments of the same general nature as those found in the Devonian area; and the green schists may unhesitatingly be regarded as an altered series of basic igneous rocks allied to the diabases in composition, and possibly consisting in part of altered tuffs." In assigning a different colour to each of these groups Mr. Ussher has effected a great improvement on the old Survey map, though we are informed

that the field-maps of De la Beche also showed two divisions in the Metamorphic area. Owing to the intense folding there is a considerable amount of interplication, a feature well illustrated by cuts in the text. The cliff between the Outer and Inner Hope, east of Bolt Tail, shown as a section in the frontispiece to this memoir, serves to illustrate the relation of the mica-schists to the hornblende-epidote-schists in that particular area. The alternations of red and green in the latter series of schists would be very effective on a coloured plate.

East of the Salcombe estuary the green schists form the northern and southern fringes of the Metamorphic area, with a considerable tract of mica-schist country between them; whilst, west of the estuary, the green schists are in the middle and the mica-schists form the outsides. The general strike of the green schist zone, where the two bands coalesce to form one, would seem to be approximately north-west and south-east. This direction is oblique to the general strike of the Devonians on the north, and, taken in conjunction with the fact that the eastern half of the Metamorphic boundary consists of green schists and the western half of mica-schists, seems to point to a considerable difference of orientation in the two systems. Yet the author fails to trace any evidence of pre-Devonian disturbance.

A detailed description of the structure and petrology of the mica-schists and green schists follows, and the features of possible resemblance to their presumed analogues in the Devonian rocks are carefully pointed out. With reference to the mica-schist series, he observes that in parts of the district it would be difficult to distinguish the least altered examples of mica-schists, finely interlaminated quartz-mica-schists, and quartz-schists from examples of the corresponding Devonian sediments. Professor Bonney, he says, has drawn attention to this fact, and ascribes it to the deformation of true schistose character in the former case and to the simulation of schistose character in the latter. There are many valuable petrological notes by Mr. Teall relating both to the mica-schist and green schist series.

Lastly, the author concludes that the only volcanic development in the Devonian area comparable to the green schists is furnished by the Ashprington series. "The correlation between these groups, should the Devonian age of the Metamorphic rocks be established, is, however, less probable than the connection of the green schists with the igneous rocks of Stoke Fleming or with those in the Torcross group" (p. 50). As regards the latter suggestion, we may observe that it accords but doubtfully with the feeble and scattered development of igneous rocks in a group of slates such as that of Torcross, and seems, moreover, in direct contradiction to the stratigraphy as shown in the diagram on p. 62. The advocates of the metamorphism of the Devonian beds had better stick to the Ashprington volcanic series, the chief difficulty, of course, being to transport it within the Metamorphic area.

Nature of the Boundary between the Northern and Southern Areas.

This is perhaps the most interesting chapter in Mr. Ussher's memoir. "On the whole," he says, "the boundary of the Metamorphic area can be located with tolerable certainty owing to the comparatively unaltered condition of the slates and shales on the north side. The rapid change from one group to the other is equally evident where the green schist series is in contact with the slates, and between Malborough and Hope, where the mica-schists are in contact with them." This is a terrible blow to the old notion of progressive metamorphism, and is all the more severe because it includes in the Devonian or northern area rocks which were mapped as Metamorphic in the old Survey sheets. Professor Bonney and Miss Raisin have done good service here, and although Mr. Somervail was able to effect a slight correction in the latter author's map, it only served to shift the boundary-line somewhat to the northwards.

When we come to the consideration of local details, it must be admitted that there is a certain degree of obscurity as to the actual position and character of the boundary on the east coast (Greenstraight). This has struck more than one observer. Mr. Ussher says that "there is no break in this section, which could be taken as a fault boundary, or satisfactory junction between altered and unaltered rocks." This seeming obscurity on the east coast, which is usually the first point visited, may in part account for the controversial character of the entire subject as to the relations of the Devonians to the Metamorphics.

There seems to be better evidence further inland, for at Kellaton, he says, unaltered grey slates of the Devonian group become gradually intercalated with "yellowish-brown beds and harder rotten brown stony bands, giving place to soft peroxidated and yellow-brown materials with seams of soft reddish and dark-grey shale or schist with highly micaceous surfaces and whitish interfilming. The section appears to be a more or less rapid passage from unaltered sedimentary to decomposed volcanic material, which cannot be separated from the green schists." Since these 'brown beds' appear in the junction sections to be more or less connected with the green schists, it is only natural to suppose that they constitute a sort of decomposed and peroxidized selvage of those rocks, into which most probably portions of the Devonian slates may have been forced by pressure. They are in no sense passage beds, but simply portions of the green schists in a state of decay owing to their peculiar position. Mr. Ussher had previously stated (Proc. Geol. Assoc., vol. xvii, p. 123) "that the junction between the Devonian and altered rocks is almost invariably marked by the presence of rusty-brown decomposed rocks, generally containing hard carbonates. These rocks often intervene for a distance of several chains. The contrast between the comparatively unaltered Devonian slates and the highly altered rocks, on either side of this neutral zone, is everywhere strongly marked; nor were any

evidences of progressive metamorphism detected in the Devonian rocks approaching the boundary." (See antea, p. 31.)

It is a fortunate circumstance that the numerous creeks in connection with the Kingsbridge estuary afford sections of the boundary-line, which are in some respects better than those on either coast. This remark especially applies to the Southpool Creek junction-section (west bank), described and illustrated on pp. 54 and 55. The beds representing the Devonian portion of the junction rocks at this place consist of grey slates with brown ferruginous films and a local abundance of quartz veins. These beds are intersected by several small faults, whilst the schistosity dips are mostly northerly at angles from 50° to 70°: they can be correlated with the slaty series south of Tinsey Head (east coast) and between Beacon Point and Mouthwell (west coast). The beds above described are separated by a thrust with a northerly inclination "from yellowish-brown and reddish-brown decomposed shales with tough masses, revealing hard whitish carbonate, and definite beds of chocolate-brown rock"; but the spot where the brown rocks are in normal contact with the green schists, which succeed on the south, is unfortunately obscured.

If we are right in supposing that the 'brown rocks' are, in the main, the decomposed selvage of the green schists, and if the author's section (fig. 23) and descriptions are to be relied on, we have here an admirable illustration of what may prove to be the true stratigraphical relations between the Metamorphic mass of the southern area and the Devonian rocks of the northern area, viz., the impinging of two entirely different rock systems upon each other. For such a line of contact the term 'fault' is scarcely adequate, since, owing to the crush and admixture of opposing materials, there has been established a kind of border medley to which the author has in some cases applied the term 'intermediate series.' Although this intermediate series, as we might expect, varies in character at different points, yet so far as the 'brown rocks' are concerned we must allow that the Metamorphic area has contributed the greater part of them. This supposition is, furthermore, confirmed by the facts observed in connection with the Kingsbridge estuary junction-section (east side).

We now come to an important change in the character of the boundary-line on the south side, viz., the substitution of the mica-schist series for the hornblende-epidote or green schist series. West of the Kingsbridge estuary the northern band of green schists is split up into two groups, and the northern group is continued in a westerly direction as an irregularly interplicated series of mica-schist and green schist until the former wholly prevails as the boundary rock. It is significant to note that henceforth, until the Hope section is reached, no further signs of either green rocks or decomposed brown rocks are encountered. Very little is said in the memoir about the junction phenomena along the mica-schist boundary. In one place the junction schists are said to be soft, yellow and red in part, and very micaceous. A specimen, according to Mr. Teall, is almost entirely composed of muscovite, with large

opaque grains, apparently pseudomorphs after pyrite, and tourmaline as an accessory (p. 58). Further on the surface stones afford evidence of partially peroxidized mica-schists and quartz-schists.

The author considers the Hope junction-section to be the most complete in the area, and the beach reefs supply the evidence which would otherwise be lacking in the intervals between the cliff sections. Yet, for all this, the actual line of junction seems doubtful, and we are left very much in the dark after studying the diagram (fig. 25), where the author might easily have given us his view as to the actual position of the boundary. He states in the text (p. 62) that the Hope section exhibits the east coast and Kingsbridge estuary 'brown rocks' in plicated conjunction with rocks ascribed to the Devonian slates on the north side of Hope Headland and with mica-schists on the south side of it. The crux appears to be in Hope Headland itself, and the line of junction is most likely to occur in that cliff rather than at the commencement of Mouthwell beach, as shown in the old Geological Survey map and also in the new one. Undoubtedly the presence of 'brown rocks' in this area without a corresponding development of the green schists constitutes a difficulty which requires to be explained.

Mr. Ussher admits that the line taken as a junction does not correspond to an abrupt change in the character of the metamorphism, but owing to the occurrence of the 'brown rocks' north of Hope Headland, as well as in the Headland itself, he is content to place the junction in the position assigned to it in the old Geological Survey map. Professor Bonney and Miss Raisin place the line further south, the former distinguishing the rocks immediately south of Hope Headland as "true schists" from those on the north side as "never more than schistose." Thus it would appear, notwithstanding Mr. Ussher's statement that the Hope junction-section is the most complete in the area, there seems yet to be an element of doubt as to where the boundary-line should be drawn, if indeed it is possible to draw an exact line under such conditions as are presented by the juxtaposition of two opposing rock systems.

Conclusion.

The above details with regard to the boundary between the Devonian and Metamorphic rocks are undoubtedly difficult to follow by those who possess little or no acquaintance with the localities, though possibly a general idea of this peculiar apposition of the two series may be obtained. In the new map the boundary-line is drawn with precision, but no fault is indicated, and everyone is at liberty to draw his own conclusions as to the true nature of the junction. It is perfectly clear that an immense change is accomplished within a short distance on either side of the boundary, the intervening space for the length of a few chains being occupied by rocks which sometimes partake of one character and sometimes of the other. These conditions fully justify the Director, in his preface, in stating that "a striking feature of the area in question is the contrast between the intensely folded but comparatively

unaltered Devonian rocks on the north and the Metamorphic rocks on the south."

The question then naturally arises: what are the true relations of these two different systems to each other? It is admitted that Mr. Ussher has not been able to settle the question of the age of the Metamorphic rocks by stratigraphical evidence, yet we are fully prepared to agree with the Director that "his detailed mapping of the green schists and his careful description of the line which separates the altered from the unaltered rocks will be found of value to all future workers in the district." This is perhaps as much as we can expect from an official memoir in explanation of sheets, which are a great improvement on the old Geological Survey map, where an unproved hypothesis was allowed to take the place of a simple record of facts.

It may be that the theory of metamorphosed Devonians is not altogether forgotten, for we find Mr. Teall observing (p. 45) "that whatever the age of the rocks in the Metamorphic area may be, it is practically certain that they represent a series of arenaceous and argillaceous deposits with which a considerable amount of basic igneous material was associated, and that, so far as original composition is concerned, they can be matched by rocks occurring in the Devonian area, though the igneous and sedimentary types do not occur in the same relative proportions." The petrographer thus invites the stratigraphist to perform a feat of legerdemain whereby certain Devonian rocks, such as the Ashprington volcanic series, might by some hypothetical anticlinal arrangement be transported into the requisite position. Since the application of the doctrine of progressive metamorphism finds no favour with Mr. Ussher, there is nothing left for the advocates of the metamorphism of Devonian rocks but some such explanation as is suggested, rather than put forward, in the diagram on p. 62. Here the distant Middle Devonian, with its volcanics, seems prepared to jump over the whole of the intermediate Lower Devonian and reappear in the extreme south as the schistose series of the Salcombe peninsula. It is uncertain, however, on which horse the author is prepared to win, for we remember that he has shown a preference (p. 50) for the Torcross group with its attenuated igneous bands. True, this is a much shorter leap, but the horse is only a poor one when he is landed on the other side of the ditch.

In bidding farewell to this subject we must express a hope that more sober views will ultimately prevail; and the desperate shifts to which the advocates of metamorphosed Devonians are now reduced seem to indicate that the period is not far distant when mere hypothesis must give way to a more reasonable and probable interpretation of the facts recorded in this memoir. We rejoice to see that even among the local geologists Mr. Harford Lowe (Trans. Devon Assoc., vol. xxiii, p. 523) has taken an essentially reasonable view of the relation of the South Devon schists to the Devonian slates, and some of his suggestions in that connection are well worthy the consideration of professional geologists. The

extraordinary crumpling of the Devonians of the northern area, and the flattening of their fossil beds, such as they were, into mere films, are best explained on the presumption of a pressure of unusual intensity, such as might result from a squeeze between two rock masses of independent origin, viz., Dartmoor on the north and the Metamorphic schists on the south. It cannot be denied that this interpretation accords best with the stratigraphy of the region and the general structure of the Damnonian peninsula; possibly also, in the main, with the petrology of the rocks of both the northern and southern areas.

II.—Cretaceous Cephalopoda from the Hokkaidō. Part II: *Turrilites*, *Helicoceras*, *Heteroceras*, *Nipponites*, *Olcostephanus*, *Desmoceras*, *Hauericeras*, and an undetermined Genus. By Hisakatsu Yabe, University Hall, Imperial University of Tōkyō. Journal of the College of Science, Imperial University, Tōkyō, Japan, vol. xx, art. 2, pp. 45; 6 plates. 1904 (published Oct. 15, 1904).

THE first part of this work (noticed in the Geological Magazine, September, 1903) contained a description of those Ammonites which are included in the genus *Lytoceras*, s.str., and the genera, or subgenera, *Pseudophyllites*, *Gaudryceras*, and *Tetragonites*.

In this second part the following genera are described: (1) *Turrilites*, *Helicoceras*, *Heteroceras*, and *Nipponites*; (2) *Olcostephanus*; (3) *Desmoceras* and *Hauericeras*. "The order in which the different groups are here treated is not due," says the author, "to the presence of any mutual relations existing among them, but merely for the sake of convenience and of avoiding too long a delay in the publication of the paper."

Dr. Yabe has endeavoured to make his work on these Cretaceous Ammonites from the Hokkaidō as complete as possible; he has studied not only their morphology, but the development of several of their predominating types, "for," says he, "it has now become clear that a mere morphological study of adult specimens is not sufficient for the establishment of their real affinities, and that by the study of their development only can such knowledge [be] attained."

Everyone who is acquainted with the Cretaceous Cephalopoda will agree with Dr. Yabe that in their study "one of the most difficult tasks is to define the exact limits of the different genera established on the turreted forms of Ammonites." D'Orbigny included these forms under one of the three genera *Turrilites*, *Helicoceras*, and *Heteroceras*, recognising in the first-named genus two distinct groups, *T. rotundati* and *T. angulati*. Subsequently Sharpe and Stoliczka referred the first of these groups to the genus *Helicoceras*, reserving the name *Turrilites* for the group *T. angulati*. After giving the various classifications that have been suggested for these turreted forms, concluding with that proposed by Professor Hyatt in 1900 in Eastman's translation of Zittel's Text Book of Palæontology, the author says:—"Hyatt's classification by creation of

many new genera may possibly be an improvement on the previously existing ones, but it cannot be followed here, for the generic diagnoses and discussions on the taxonomy are not yet published. Therefore, the present writer is obliged to follow the old and well-known classification of D'Orbigny as modified by Sharpe and Stoliczka, though it is apparently unnatural."

The turreted forms are comparatively rare in the Hokkaidō Cretaceous rocks. Only two forms of *Turrilites* are recorded: one represented by a single small example resembling *T. Mantelli* and especially *T. Bergeri*, although specifically distinct from either; the other, also represented by only a single example, belonging to a much larger species, described as new, somewhat resembling, but less elongated than, *T. tuberculatus*. Two new forms of *Helicoceras* are described, one of which is doubtfully referred to this genus, whilst four new species and a new variety are doubtfully referred to the genus *Heteroceras*.

But of all the turreted forms described by the author the most remarkable is certainly the specimen for which the new genus *Nipponites* is proposed. Its shape is thus described: "At first the shell forms a more or less flat spiral coil wound sinistrally as in *Helicoceras*. . . . . The further growth is no longer spiral, but it consists in turning to the right and then to the left several times and thus forming many U-shaped curves which cover the first part of the shell from six directions, so that the plane of the curves roughly corresponds to the six sides of a cube." Notwithstanding the fact that the present species is represented only by a single specimen, Dr. Yabe concludes that "the mode of coiling the whorls can neither be accidental nor due to a loss of power to produce the regularly wound shell, as it is too regular to admit any such supposition. That it is a *Turrilites* or some allied genus which has modified its mode of growth on account of its advanced age is also inconceivable. Therefore, this formation of several U-shaped curves must be ascribed to the inherent power of the animal." It is for these reasons that Dr. Yabe has considered this single specimen to be worthy of a new generic name. From the form of the shell the author concludes that "the animal led neither a free swimming life nor a sessile one, but was a creeper on the sea-bottom, as is the generally accepted view of *Turrilites*."

An interesting Ammonite, which is too imperfect for its proper generic determination, possesses characters which ally it with the Indian species *Olcostephanus superstes* and *Ammonites rudra*, two species that are provisionally placed in *Olcostephanus* by Dr. Kossmat, who recognises, however, their phyletical relations to *Vascoceras* on the one hand and to *Acanthoceras* on the other.

A new species of *Olcostephanus* is described, having its nearest ally in a form described by Dr. Whiteaves from the Cretaceous of the Queen Charlotte Islands, whilst to *Hauericeras*, in addition to the genotype, *H. Gardeni*, that has been recognised in Natal, in Southern India, in Vancouver Island, in the Hokkaidō, and possibly also in Tunis and in Galicia, the author refers a new species, which is

closely allied to a species from the Cretaceous of France. *Desmoceras* is represented by two forms, one of which is considered to be a new variety of the species *D. Dawsoni* which Dr. Whiteaves described from the Queen Charlotte Islands, whilst the other is regarded as new.

All the species are well illustrated on the six plates accompanying the work.

We most heartily congratulate the author upon this further most interesting contribution to our knowledge of the Cretaceous Cephalopoda from the Hokkaidō. G. C. C.

III.—Second Report of the Geological Survey of Natal and Zululand. By William Anderson, F.R.S.E., F.G.S., Government Geologist. 4to; pp. 171, with 11 plates and maps. (London, 1904: West, Newman & Co., 54, Hatton Garden.)

THE Report contains an account of the Survey operations for the years 1901–2, with two valuable and important contributions to the Palæontology of East Africa, one by Mr. Robert Etheridge, of Sydney, and the other by Mr. A. C. Seward, F.R.S., of Cambridge. It should be mentioned that Mr. W. Anderson is still the only member of the Survey Staff, and that its offices are limited to two small rooms in Pietermaritzburg, altogether inadequate for the proper storage of the rock specimens and fossils; and but for the fact that various collections were promptly sent for identification to palæontologists in different parts of the world, their accumulation would have made the offices practically inaccessible! On the other hand, the Natal Government do not seem to have stinted the expenditure for the publishing of the Report, which, as regards paper, print, plates of fossils, and coloured maps, has been brought out very satisfactorily, and might be commended for imitation to Surveys nearer home.

Mr. Anderson's field-work has been devoted mainly to a rough survey of the province of Zululand; in part to the coastal areas on the east, and in part to the north-western border, where he has been able to connect his work with that of Dr. Molengraaff in the Vryheid district. The whole littoral area of Zululand, in places 50 miles in width, is uniformly flat or slightly undulating, some areas swampy, others sandy, and largely covered with dense wood or scrub. The rivers by which it is traversed cut deep into the subsoils, but do not expose the rocks beneath as a rule. With the exception of calcareous sandstones and conglomerates in two or three small areas, the rocks shown on the coast are shales, marls, calcareous beds, and lignites, with soft sandy deposits of all colours. These are considered to be of Cretaceous age; the only indications of Tertiary rocks were some calcareo-arenaceous pebbles found on the coast, which contained fragmentary *Lithothamnion* and numerous Foraminifera, and an impure Diatomaceous deposit, near Lake Sibayi, which may be of Pleistocene age.

Mr. Anderson has also examined the Ecca series in the basin of the Black Umfolosi, near the north-western boundary of

Zululand, where the whole series, from the glacial (Dwyka) conglomerate upwards, is well developed. Here, as elsewhere in the country, the plant and coal-bearing beds occur in the higher part of the series, and many of the shale beds contain abundant remains of *Glossopteris* and *Phyllotheca*. With the exception of the coal-bearing series at the base of the Drakensberg, containing *Thinnfeldia* and *Pterophyllum*, belonging to the Stormberg series, and approximately of Triassic age, Mr. Anderson states that all the coal-bearing rocks of Natal and Zululand contain a *Glossopteris* flora and are of Ecca or Permo-Carboniferous age.

The Dwyka, or, as Mr. Anderson prefers to term it, Ecca Conglomerate, is widely distributed in Zululand, and occurs at all heights from the sea-level to the highest portion of the plateau; detached outliers of it are often present on the higher ridges and mountains. In a few localities, sandy beds, free from pebbles and boulders, are intercalated between the typical conglomerates. Striated rock-pavements also occur; the author mentions a fine example in the bed of the Umfolosi river, where a striated quartzite pavement, directly overlain by the glacial conglomerate, is partially denuded by the river. The author feels no doubt that this ancient conglomerate is a till or boulder-clay of terrestrial origin.

The Cretaceous fossils described by Mr. Etheridge are from a shelly limestone at Umkwelane Hill, a few miles inland from the coast. The rock is crammed with fossils, which, however, invariably break up in the attempt to free them from the hard matrix. The fossils are largely Pelecypods and Gasteropods, with a few Cephalopods belonging to *Placenticeras*, *Creniceras*, *Hamites*, and *Baculites*, and some fragmentary shark's teeth.

In all 37 species of mollusca, belonging to almost as many genera, have been determined, and their affinities carefully worked out by Mr. Etheridge, and they are admirably figured on three plates. Several species show relationships to forms from the Trichinopoly groups of India, the Chico and Tejon groups of California, the Fort Pierre and Foxhills groups of the north-west of the United States, and the Greensands of New Jersey; but no resemblance to those forming the Australian Cretaceous fauna.

Mr. A. C. Seward's report on collections of Natal fossil plants treats first on those from the Ecca coal-series of Umhlali, on the north-east coast of Natal. In these beds "*Glossopteris Browniana* is exceedingly abundant; *Noeggerathiopsis* is possibly represented, and stems doubtfully placed in the genus *Schizoneura* are fairly plentiful. No undoubted *Gangamopteris* has been recognized. On the whole the evidence would appear to support the view that the plant-beds are approximately homotaxial with the Damuda beds of India, and belong to the Beaufort Series of South Africa." The plants from the Drakensberg Range in West Natal comprise species of *Thinnfeldia* and *Pterophyllum*, together with a species of doubtful affinity, and of these Mr. Seward says that they point to an horizon considerably above that of the Umhlali plant-beds, and approximately Rhætic or Lower Jurassic.

This second Report of the Natal Geological Survey is a valuable addition to our knowledge of South African geology, and it furnishes a strong argument in favour of Mr. Anderson's appeal to the Natal authorities for further assistance to enable him to continue his arduous undertaking.

IV.—Mollusques tertiaires du Portugal. Planches de Céphalopodes, Gastéropodes, et Pélécypodes laissées par F. A. Pereira da Costa; accompagnées d'une Explication sommaire et d'une Esquisse géologique par G. F. Dollfus, J. C. Berkeley Cotter, et J. P. Gomes. Commission du Service géologique du Portugal. 4to; pp. 120, 1 tab. stratigr., 1 portrait, and 28 pls. (Lisbonne, 1903–1904.)

WHEN the Geological Commission of Portugal was instituted in 1857 to investigate the geology and to produce a geological map of the country two Directors were appointed, one for the geological work and the other for the palæontological studies and the care of the collections. To the latter post F. A. Pereira da Costa, then Professor of Mineralogy and Geology at the Polytechnic School of Lisbon, was appointed. In the following year all the collections of natural products from the Museum of the Academy were combined with those belonging to the Polytechnic School and constituted the National Museum of Lisbon; this was divided into two sections, mineralogy and zoology, and Pereira da Costa was made Director of the former department.

His appointment on the Geological Commission led him to decide to publish his researches on the Tertiary fossils of Portugal. Under the title *Molluscos fosseis.—Gastéropodes dos depositos terciarios de Portugal* two fascicules only were issued, dated respectively 1866 and 1867, the two comprising 252 pages of text and 28 plates. But besides these, 28 other plates of Cephalopoda, Gasteropoda, and Pelecypoda had been drawn and printed off (to the number of seven or eight hundred) for succeeding fascicules. At the conclusion of the Geological Commission in 1868 Pereira da Costa resumed his duties at the Polytechnic School, and these unpublished plates were deposited in the Library of the Mineral Section of the National Museum, which contained the specimens that Pereira da Costa had studied. But there was no text with them, and unfortunately no descriptions of the fossils that had been drawn were found amongst Pereira da Costa's papers after his death in 1889.

The plates having been handed over to the Geological Survey by the present Director of the Mineral Section of the National Museum, M. Ferreira Roquette, they are issued in the work now before us. With the assistance of M. J. C. Berkeley Cotter, of the Geological Survey, and M. J. P. Gomes, naturalist at the Museum, the explanations of the figures have been prepared by M. Gustave F. Dollfus, the French palæontologist, and are based upon the original specimens whenever possible, or upon authenticated examples of the species; whilst an original and extremely interesting sketch of the

marine Miocene of Portugal has been supplied by M. J. C. Berkeley Cotter, a biographical sketch of Pereira da Costa being furnished by M. J. P. Gomes. M. J. F. Nery Delgado, the present President of the Geological Survey, contributes a Preface to the work, in which he explains that the two fascicules issued by Pereira da Costa and the 28 new plates by no means represent the whole of the marine Miocene fauna of Portugal; many discoveries having been made since the appearance of the two fascicules, whilst there are many gaps in the new series, notably among the Pelecypoda. Further, that some genera are incompletely represented, whilst others are entirely omitted. "Nevertheless," says M. Delgado, "such as they are, these twenty-eight plates are very interesting; they represent many species often imperfectly known, either hitherto badly figured or even entirely new."

A palæontological note appended to the work contains figures and a description of a new species of *Anomia*, named *A. Choffati*, after M. Paul Choffat, who is so well known for his excellent work in connection with the Geological Survey of Portugal, to which he is attached.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—November 23rd, 1904.—J. E. Marr, Sc.D., F.R.S., President, in the Chair. The following communications were read:—

1. "On an Ossiferous Cavern of Pleistocene Age at Hoe Grange Quarry, Longcliffe, near Brassington (Derbyshire)." By Henry Howe Arnold-Bemrose, M.A., F.G.S., and Edwin Tulley Newton, F.R.S., V.P.G.S.

During quarrying operations in Hoe Grange limestone quarry in April, 1902, the workmen broke into a cavern. The discovery was first made known to the writers by Mr. J. Ward, of the Cardiff Museum, but the news of mammalian bones being found soon spread, and many of the remains were carried away. An arrangement to work the cave systematically was made, with the permission of the owner, Major Nicholson, and it has now been entirely worked out, the results being given in the present paper.

The quarry is situated near the top of the plateau, at about 1,100 feet above Ordnance datum. The cave is evidently a master-joint in the limestone, enlarged by water, and, besides being a swallow-hole, has served as a hyæna den. The large number of mammalian remains found includes lion, hyæna, rhinoceros, *Elephas*, and other Pleistocene forms; but besides these there were numerous bones and teeth of fallow-deer, mixed with the Pleistocene remains at all horizons in the cave. The physical conditions are such as to preclude, as the authors think, any idea of a redeposition of the bones at any date subsequent to the Pleistocene Period; and it is concluded, therefore, that the fallow-

deer (*Cervus dama*) was a Pleistocene species, although hitherto supposed to be a much later introduction.

2. "The Superficial Deposits and Pre-Glacial Valleys of the Northumberland and Durham Coalfield." By David Woolacott, D.Sc., F.G.S.

Six volumes, published by the North of England Institute of Mining and Mechanical Engineers, contain a large number of borings made in the northern coalfield. A considerable proportion of these are most valuable in showing the nature and distribution of the superficial deposits. From them and from field-mapping it is possible to form a fairly accurate conception of the pre-Glacial floor of the district and its drainage, and also of the relative changes of level before, during, and after the Glacial Period. The chief superficial deposits include the following:—(1) the stony Boulder-clay; (2) the Upper Clay, including (*a*) the prismatic clay and (*b*) the leafy clay; and (3) deposits of Sand and Gravel occurring below, in, or upon the Clay. The last include raised beaches, which decline in height when traced northward and southward from Cleadon and Fulwell, with a gradient of from 3 to 6 feet per mile.

The surface deposits lie arranged in the valleys formed before the Glacial Period, and often reach a considerable depth. They fit upon and level up the Glacial inequalities of the country, and are not found above 1,000 feet. The base of the Drift is in some cases as much as 140 feet below sea-level, and in one spot the thickness bored through is 233 feet. By inserting all available borings in maps, it is possible to gain some idea of the direction and depth of the valleys. In this way the following pre-Glacial valleys have been located:—The Tyne and its tributaries, corresponding in general trend with the present Tyne, which is superimposed upon it; the 'Wash,' which joins the present course of the Wear with the Tyne, and has the Team superimposed on its northern part; the upper Wear, which received all the waters from the west of Durham county, took up several large tributaries between Bishop Auckland and Durham city, and passed through the 'Wash' into the Tyne; the Sleekburn Valley; and the Druridge Bay depression, into which the pre-Glacial Coquet probably ran. Thus in pre-Glacial times the Tyne and the Tees were the major rivers, and the other streams were tributary to them; the main changes have taken place in the lower, and not in the higher, parts of the rivers. The post-Glacial Wear has breached the Permian escarpment, and many gorge-like valleys have been cut since the uplift which produced the raised beaches. The dependence of the contour of the country on its geological structure was much more pronounced in pre-Glacial times than at present.

II.—December 7th, 1904.—J. E. Marr, Sc.D., F.R.S., President, in the Chair. The following communication was read:—

"The Chemical and Mineralogical Evidence as to the Origin of the Dolomites of Southern Tyrol." By Prof. Ernest Willington Skeats, D.Sc., F.G.S.

Recent work on modern coral-reefs has shown that these limestones contain very little, if any, insoluble residue. The study of the relative proportions of the organisms composing these reefs, and the alterations that they undergo, has further shown that corals play a subordinate part in them, and that calcareous algæ, foraminifera, and other organisms form the bulk of the rocks of the reefs. The author has applied this information in the examination of collections from the much debated area of the Dolomites of Southern Tyrol. The chemical examination of numerous specimens from the Schlern dolomites of the Schlern, the Langkofl, the Marmolata, the Sella, the St. Cassian district, the Richthofen Reef, and numerous other localities, is described, so far as relates to the proportions of lime and magnesia and of insoluble residue. These results are compared with similar analyses of limestones from lower and higher horizons. Many of the dolomites are devoid of insoluble residue, and where this is present it can generally be attributed, as in the raised reefs of Fiji, etc., to the association with contemporaneous volcanic rocks. The action of solution during the slow accumulation of deep-sea limestones, and the presence of terrigenous material in organic deposits forming near the shore, give to these limestones a much larger proportion of insoluble residue. It is therefore probable that the Schlern dolomites represent a Triassic 'coral-reef,' using the term in the modern, more extended, sense. The author proceeds, on this hypothesis, to suggest the conditions under which the dolomite may have been deposited in the different parts of the area in question. He next proceeds to the microscopical examination of specimens, with a view to the study of the organisms contained in them. While the limestones have undergone mineralogical and chemical changes similar to those of recent coral-reefs, they contain a suite of organisms comparable with those of the latter, when due allowance is made for the loss of structure due to more complete dolomitization. Forty-five per cent. of the sections yielded no trace of organic structure. In the others, calcareous algæ are the commonest fossils, echinoderm-spines and lamellibranch-shells are not uncommon, while foraminifera are occasionally found; undoubted corals are extremely rare. But reef-forming corals, gasteropoda, and some of the calcareous algæ are built of aragonite, and hence are likely to disappear under the operation of mineralogical changes; while even the more stable organisms with calcite skeletons begin to lose structure, owing to the invasion of crystals of dolomite.

With regard to the origin of the dolomite-masses, it is shown that the conditions favourable to their formation were:—(*a*) shallow water between 0 and 150 feet, and corresponding to a pressure of 1 to 5 atmospheres; (*b*) the presence of carbon-dioxide in comparative abundance causing partial solution of the limestone, and the possibility of chemical change with the magnesian salts in sea-water; (*c*) porosity of the limestones facilitating the movement of magnesian solutions; and (*d*) sufficiently slow subsidence or elevation to render the change from calcite to dolomite complete. Locally, dolomite is deposited directly from solution in confined

areas or cavities in the rock; while the Raibl Dolomite, associated with gypsum, was formed by the concentration of sea-water in land-locked areas.

EDINBURGH GEOLOGICAL SOCIETY, October 19th, 1904.—Mr. B. N. Peach, LL.D., F.R.S., of H.M. Geol. Survey, President of the Society, in the chair. Opening address by the President: The Higher Crustacea of the Carboniferous Rocks of Scotland.—As early as 1835 Scouler described *Dithyrocaris*, a nebalid crustacean from the Lower Carboniferous rocks of Scotland. In 1861 Salter founded the genera *Palæocrangon* and *Anthrapalæmon*, from specimens collected by the Rev. Thomas Brown and Dr. Grossart from the Carboniferous rocks of Fife and Lanark respectively. These he thought to be macrurous decapods. Huxley, in 1862, described a specimen from Paisley, under his genus *Pygocephalus*, which he rightly placed among the schizopods.[1] From 1863 to 1882 several species of *Anthrapalæmon* were described by Salter, Etheridge, jun., and B. N. Peach, mostly from materials gathered from the Lower Carboniferous rocks, for the Geological Survey, by Jas. Bennie and A. Maconnochie. From this material Dr. Peach erected the genus *Pseudogalathea*, and showed that the American genus *Palæocaris* of Meek and Worthern occurred in Scottish rocks. With the exception of the last genus these crustacea were held to be macrurous decapods.

On the publication of the Report on the Challenger Schizopods by G. O. Sars, Dr. Peach had reason to change his opinion, and after studying a great deal of new material gathered for the Geological Survey by A. Maconnochie, and from material from Ardross in Fife obtained by William Anderson, he has been able to demonstrate that *Palæocrangon* belongs to the family *Euphausiidæ* and *Anthrapalæmon* and *Pygocephalus* to the *Lophogastridæ*, while *Palæocaris* has been found to belong to the family *Anaspidæ* made to hold the recent *Anaspides* of G. M. Thompson. These points were shown to the meeting by means of lantern slides photographed either direct from the fossils or from drawings made by Dr. Peach. Dr. Peach also showed photographs of schizopods which had assumed squillid characters. He was of opinion that in Carboniferous times the schizopods were the highest forms of crustacea then extant, and that the decapods had not then been evolved.

From the nature of the sediments in which their remains are embedded, and from the other fossils found associated with them, these old schizopods must have lived in shallow water near shore. At present the *Euphausiidæ* are for the most part pelagic, the *Lophogastridæ* inhabit the bed of the deep sea, while *Anaspides* has only yet been found in a fresh-water pool in the mountains

[1] See also paper by Dr. H. Woodward in Trans. Glasgow Geol. Soc., 1866, vol. ii, pp. 234–247, pl. iii, giving figures and descriptions of *Pygocephalus Cooperi*, *P. Huxleyi*, *Anthrapalæmon Grossartii*, etc.—EDIT. GEOL. MAG.

of Tasmania. The decapods have now usurped the present shores and the shallow seas.

Dr. Peach further showed that all the above families existed in the earliest Carboniferous times, and that they must have branched off from a nebalid stem at a much earlier geological date.

Mineralogical Society of London, November 15th.

Professor H. A. Miers, F.R.S., President, in the chair. Dr. J. W. Evans described two new forms of quartz-wedge, by means of which approximate quantitative estimations can be readily made of the double refraction of minerals in small grains or in rock-sections. Mr. J. Currie contributed a note on some new localities in Scotland and the Faroes of gyrolite and tobermorite, and Mr. C. R. Lindsey one on the occurrence of microscopic crystals of brookite with anatase in the Cleveland ironstone. Mr. R. H. Solly exhibited and described various minerals from the Lengenbach quarry, Binnenthal. Three of these were new, viz. marrite and bowmanite, of which the chemical composition has not yet been determined, and lengenbachite, which has been shown by Dr. Hutchinson to be a sulph-arsenite of lead containing some copper and antimony, and having a specific gravity of 5·8. Marrite occurs in small lead-grey crystals resembling modified cubes, and lengenbachite in thin lead-grey blade-shaped crystals, some as long as 40 mm., showing a highly perfect cleavage. Marrite crystallises in the oblique system with $a : b : c = 0{\cdot}57634 : 1 : 0{\cdot}47389$, and $\beta = 88° 45'$, while lengenbachite is probably anorthic. Bowmanite occurs in small honey-yellow rhombohedral crystals with $111 : 100 = 53° 50'$. It has a highly perfect cleavage parallel to 100, and a specific gravity of about 3·2. The author also described twinned crystals of seligmannite dispersed over large crystals of dufrenoysite and baumhauerite, and curious highly modified crystals of blende showing a thin metallic lead-grey coating. Mr. H. L. Bowman described crystals of a mineral from Cornwall which had been sent to him for determination by Mr. F. H. Butler. They were found to be bertrandite, a mineral new to the British Isles. Mr. G. F. Herbert Smith exhibited a slightly modified form of the hand refractometer which he had previously described. Mr. H. Hill contributed notes on some applications of the gnomonic projection to crystallography, and on the construction of crystallographic projections.

Manchester University Geologists' Association.

A meeting was held in the Geological Lecture Theatre of the Owens College, Manchester, on December 8th, at which it was resolved to establish a Manchester University Geologists' Association. The object of the Association is to afford a centre of social reunion for the discussion of geological subjects. Past and present students of the University are eligible for membership, also others interested in geology who may be recommended by the Committee.

Professor Boyd-Dawkins was elected President; Mr. B. Hobson and Mr. Winstanley, Vice-Presidents; Mr. W. J. Hall, Secretary; and Mr. O. B. Leigh, Treasurer; and in addition Mr. C. R. Lindsey, Mr. H. B. Hewlett, and Mr. G. Hickling were appointed members of the Committee.

The meetings are to take place monthly, during the University Session, at the Owens College, and excursions will be arranged to places of geological interest in the Spring and Summer.

CORRESPONDENCE.

THE LOWER CULM OF NORTH DEVON.

SIR,—In the GEOLOGICAL MAGAZINE, November, 1904, pp. 530–32, appears a Note by Dr. Arthur Vaughan on the above beds.

Never having worked in the Carboniferous Limestone areas of Chepstow, etc., or the foreign equivalents referred to, I am unable to express an opinion on the conclusions arrived at by Dr. Vaughan. But I must take exception to the observations contained in the last paragraph of p. 531 commencing "I further deduce," etc.

The beds from which the fossils north-west of South Molton were collected *are* the *Posidonomya* beds, and these fossils occur in calcareous bands intercalated with the *Posidonomya* shales and limestones. I cannot, therefore, accept the statement that these beds are at a "somewhat lower level" than those of Codden Hill. On the contrary, I believe them to be the continuation of the Venn and Swimbridge beds and therefore above the highest zone of Codden Hill. Dr. Vaughan admits that he is not personally acquainted with the Codden Hill district. May I be allowed to suggest that he makes himself so, when I think he will see that an area such as this is not quite so easily 'zoned.' Or, at least, that the question can hardly be decided on the evidence of a part of the fauna only. It is a mistake, I think, to attempt such a thing without taking into consideration the *whole* of the fossil evidence, stratigraphy, and lithological character of the rocks.

The locality from which the fossils referred to come, should be described as south of *North* Aller not South Aller. This was an error on the labels of my fossils and no fault of Dr. Vaughan's.

J. G. HAMLING.

THE CLOSE, BARNSTAPLE,
November 9th, 1904.

CEPHALOPODA FROM NORTH-WEST FRONTIER OF INDIA.

SIR,—In my "Note on two Cephalopods obtained by Lieut.-Col. Skinner, R.A.M.C., from the Valley of the Tochi River on the north-west frontier of India," which appeared in the GEOLOGICAL MAGAZINE for October last (pp. 490–493), the locality of the Ammonoid (*Crioceras*?), as given in the explanation of the figures,